Docket # 4210
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USPS EXPRESS MAIL
EL 897 676 399 US
AUGUST 13 2001

Method for transmitting a plurality of information symbols

BACKGROUND

Field of the invention

The present invention relates to a method for transmitting information symbols between a first transceiver and a second transceiver by means of modulating a carrier signal according to the preamble of patent claim 1.

Description of the related technology

The types of information are designated by the term information symbol. Examples of types of information, in addition to the actual digital data words, are control signals such as clock information. In previous methods of contactless communication, the types of information are coded and digitally transmitted in the form of data words by means of modulating a carrier wave. An important area of application for this is the area of contactless identification, in which particularly transponder technology is used. These systems consist of a transponder, which is frequently integrated into a keyring pendant or a so-called smart card, and a stationary base unit which, in the case of applications in the automotive field, is fitted in an automobile. The communication between transponder and base unit is based upon an inductive coupling, in which the data is transmitted by means of a modulated carrier wave. Particularly in applications in the automotive field, the complete authentication between base station and transponder must be completed within a period of some 100 ms so that the user does not notice any delay. The information must be transmitted between transponder and base station at a high data rate in order to implement the ever higher security requirements for the authentication process. This requirement is difficult to fulfill, especially in so-called passive systems in which the transponder does not have its own power supply, and has to obtain all its energy from the electromagnetic field of the base station by means of absorption modulation. To do this, the transponder has to be located in the electromagnetic near-field region of the base station in order to be able to absorb enough energy because the inductive coupling is low in the medium air. As the near-field region is

substantially larger at low frequencies, the carrier frequencies lie in the range around 20 MHz in passive systems, which enables a range of a few cm to be attained.

Methods which function according to the previous state of the art are described, for example, for passive transponder systems in the data book of TEMIC Semiconductor GmbH, 2000, p. 319 and p. 333. In this method, all types of information are coded in the form of data words, and modulated in digitized form upon a carrier frequency. In order to decode this information in the data words, a system clock, which is gained from the carrier frequency by using dividing stages, is required in the transponder system.

The disadvantage of previous methods is that, in order to be able to decode the information contained in the data words in the receiving station, additional digital data (overhead) has to be generated by coding all types of information in the form of data words based on a protocol. This lowers the data transmission rate correspondingly. This results in additional waiting time for decoding the transmitted information, which is disturbing in time-critical applications. Another disadvantage of the previous method is that, in passive systems for decoding the transmitted data words, the system clock is derived from the frequency of the carrier with the aid of a dividing stage. With a frequency in the 20 MHz range, the dividing stage has to switch frequently within the transponder in order to generate the system clock and, in combination with the further switchover for clock generation, requires a considerable proportion of the energy which is gained by absorption modulation from the field of the base station. This substantially reduces the communication distance between base unit and transponder.

Summary of the invention

The object of the present invention is to provide a method which increases the data rate of wireless communication, and which can replace the clock generation logic in the case of passive transponder systems.

This object is solved in accordance with the invention by a method of the type mentioned at the beginning with the features of patent claim 1. Favorable embodiments are the objects of the subclaims.

According to this, the essence of the invention is, in the case of communication between a first transceiver and a second transceiver, to transmit various information symbols by means of a single carrier wave, in which different modulation indices are assigned to the individual information symbols in the first transceiver, and so to modulate the carrier wave in such a manner that at least one of the characteristic physical parameters of the carrier signal is changed in the first transceiver. As well as a frequency modulation and a phase modulation, the method according to the invention can be particularly advantageously implemented by means of an amplitude modulation.
The advantage over the prior state of the art is that, by transmitting differing information symbols, the information types only have to be partially coded in the form of data words, and this enables the data rate to be substantially increased. As well as the coded data words, additional control signals can also be transmitted directly by a carrier wave.

In an embodiment of the method according to the invention, it is possible to modulate the individual information symbols on the carrier wave with a time-shift. The number of possible information symbols which can be transmitted by a carrier wave is substantially a function of the second transceiver's sensitivity for separating them on the basis of the different modulation amplitudes.

In another development of the method according to the invention, it is possible to modulate a plurality of information symbols simultaneously on a carrier wave in order to increase the data rate even further. In order to make the separation of a plurality of information symbols easier in the second transceiver, it is advantageous if the spacings of the values between two adjacent modulation indices are of equal size, or if the value of the modulation index of the nth information symbol differs from the value of the modulation index of the (n+x)th information symbol by a constant factor which has, for example, the value 2.

In another development of the method according to the invention, the superimposition of information symbols, as well as the time-shifted modulation of the information symbols can be combined with successive carrier frequency periods of differing length. The advantage of this is the

possibility of increasing the total number of information symbols transmitted by a carrier wave without reducing the spacing between the values of the modulation indices too much for simple separation in the second transceiver. Compared with the prior state of the art, the method thus enables a multitude of information symbols to be transmitted on a carrier wave in a simple and inexpensive manner. It is irrelevant to the method whether the communication is unidirectional or bidirectional.

If, for example, a separate modulation index is assigned as an information symbol to a clock information, with the new method a system frequency for decoding the data words, for example, can also be transmitted together with the data words by a carrier wave. This enables the second transceiver to be controlled by the first transceiver in a particularly simple manner by synchronizing the second transceiver with the first transceiver. In a further development, the data rate can be variably set without coding with data words. Investigations by the applicant have shown that it is advantageous to assign a smaller modulation index to the clock signal than to the data signal.

The new method can be particularly advantageously used to replace the electronic switching for clock generation in the second transceiver. The energy consumption is substantially reduced, especially in passive systems, because the system clock is no longer generated by dividing stages and an integrated circuit in the second transceiver. This increases the maximum possible communication distance between transponder and base station. Accordingly, substantially higher carrier frequencies with correspondingly higher data rates can be used, which result in very short times for transmitting a plurality of information symbols, even for complicated authentication processes.

Brief description of the figures

The invention is shown and explained in the following by means of an embodiment in conjunction with a drawing. It shows:

Fig. 1 A carrier wave which has a plurality of modulation indices and period lengths of equal size,

Fig. 2 A carrier wave which, in addition to a plurality of modulation indices, has different period lengths.

Description of the preferred embodiments

Figure 1 shows an embodiment of the method according to the invention in which a carrier wave transmits various information symbols. To do this, the amplitude A of the illustrated carrier wave is modulated in a first transceiver (not shown) by a different modulation index being assigned to each of a first information symbol M1, a second information symbol M2, a third information symbol M3 and a fourth information symbol M4. For reasons of clarity, the arrangement of the modulation indices has been selected so that the values continually fall from M1 to M4. However, any other sequence of modulation indices is also possible. In comparison to the other information symbols, M2 to M4, information symbol M1 is distinguished by having a modulation index of 100%. During this time, which is also designated as a field gap, the second transceiver cannot absorb any energy from the field. Because of its special position, it is advantageous to use this information symbol for synchronizing the data transmission. As the other information symbols do not have modulation indices of 100%, it is possible to superimpose a further information symbol Mt with a substantially lower modulation index, to which, for example, clock information may be assigned, on these information symbols. The transmission of the clock information enables the transmitted information symbols to be decoded in the second transceiver without this having its own logic for generating the system clock. Moreover, for clarity of illustration, the same bit patterns are transmitted within the individual information symbols in the two successive periods, which have a period length of t0.

Figure 2 shows a development of the embodiment shown in figure 1 in which, in addition to the four different modulation indices M1, M2, M3 and M4 and the modulation index for the clock information Mt, the period lengths t0 and t1 are also varied. This enables another information symbol to be transmitted by a carrier wave.